

**CLAIMS**

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is as follows:

- 1 1. A method to diagnose equipment failures using an integrated approach of  
2 case-based reasoning and reliability analysis, comprising the steps of:  
3        maintaining a case base database for the equipment;  
4        receiving an equipment problem description from a user;  
5        for each component in the equipment, calculating failure probability  
6        based on historical failure and published data, using reliability theory;  
7        for each component, calculating probability of matching problem  
8        description assuming that a component fails, using case based reasoning;  
9        for each component, combining the calculated probabilities to compute  
10      the overall failure probability given the historical behavior and published data  
11      and problem description; and  
12        composing a list of component recommendations by ranking  
13      components by their overall failure probabilities and retrieving corresponding  
14      past solutions from the case base.
- 1 2. The method of claim 1, further comprising the step of producing a single  
2 list of suggested failed components based on published failure data, historical  
3 failure behavior as observed by the equipment user, and the problem  
4 description specified by the user.
- 1 3. The method of claim 1, further comprising the step of producing a list of  
2 probabilities of failure corresponding to the list of suggested failed  
3 components, with the probabilities estimated from published failure data,

4 historical failure behavior as observed by the equipment user, and the problem  
5 description specified by the user.

1 4. The method of claim 1, wherein the step of combining probabilities to  
2 compute overall failure probability uses an equipment hierarchy such that  
3 component failure probabilities are estimated in a hierarchical manner,  
4 calculated from data for the equipment at hand, if there is adequate data,  
5 otherwise, from data from an equipment group one level up in the hierarchy,  
6 and repeating the process until adequate data is found.

1 5. The method of claim 1, wherein the step of combining probabilities to  
2 compute overall failure probability uses an equipment hierarchy such that  
3 historical cases are retrieved in a hierarchical manner, from data for the  
4 equipment at hand, if there is adequate data, otherwise, from data from an  
5 equipment group one level up in the hierarchy, and repeating the process until  
6 adequate data is found.

1 6. A decision support system to diagnose equipment failures using an  
2 integrated approach of case-based reasoning and reliability analysis,  
3 comprising:  
4       a case base maintenance management system database for the  
5       equipment;  
6       a decision support system database;  
7       a decision support system client for receiving an equipment problem  
8       description from a user;  
9       a decision support system server receiving input from the decision  
10      support system client and accessing said maintenance management system  
11      database and said decision support system database, said decision support

12 system server including  
13 a real-time decision support system engine for calculating failure  
14 probability for each component in the equipment, based on  
15 historical failure and published data, using reliability theory,  
16 and for calculating probability of matching problem description  
17 for each component, assuming that a component fails, using  
18 case based reasoning, and for each component, combining the  
19 calculated the calculated probabilities to compute the overall  
20 failure probability given the historical behavior and published  
21 data and problem description and composing a list of  
22 component recommendations by ranking components by their  
23 overall failure probabilities and retrieving corresponding past  
24 solutions from the case base; and  
25 a case base update processor for copying closed failure transaction  
26 records from the maintenance management systems database,  
27 and extracting the information these transaction records to the  
28 attributes required by said decision support system engine, and  
29 indexing each transaction record by the failed component  
30 identification and the number of occurrence of failure of that  
31 particular component.

1 7. The decision support system of claim 6, wherein the decision support  
2 system server produces a single list of suggested failed components based on  
3 published failure data, historical failure behavior as observed by the  
4 equipment user, and the problem description specified by the user.

1 8. The decision support system of claim 6, wherein the decision support  
2 system server produces a list of probabilities of failure corresponding to the

3       list of suggested failed components, with the probabilities estimated from  
4       published failure data, historical failure behavior as observed by the  
5       equipment user, and the problem description specified by the user.

1       9. The decision support system of claim 6, wherein the decision support  
2       system server combines probabilities to compute overall failure probability  
3       uses an equipment hierarchy such that component failure probabilities are  
4       estimated in a hierarchical manner, calculated from data for the equipment at  
5       hand, if there is adequate data, otherwise, from data from an equipment group  
6       one level up in the hierarchy, and repeats the process until adequate data is  
7       found.

1       10. The decision support system of claim 6, wherein the decision support  
2       system server combines probabilities to compute overall failure probability  
3       uses an equipment hierarchy such that historical cases are retrieved in a  
4       hierarchical manner, from data for the equipment at hand, if there is adequate  
5       data, otherwise, from data from an equipment group one level up in the  
6       hierarchy, and repeats the process until adequate data is found.